FORM PTO-1390 (REV. 5-93)

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER
10191/2261

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)
10/070879

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED:
PCT/DE00/02421	**25 July 2000 (25.07.00)**	**02 September 1999 (02.09.99)**

TITLE OF INVENTION
SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD

APPLICANT(S) FOR DO/EO/US
Martin KESSLER and Stefan KOCH

Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unsigned)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
    ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
14. ☒ A substitute specification and marked-up version of substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information: International Search Report, Preliminary Examination Report and PCT/RO/101.

Express Mail No.: EL 829171024 US

U.S. APPLICATION NO. (if known, see 37 CFR 1.5) 10/070879	INTERNATIONAL APPLICATION NO PCT/DE00/02421	ATTORNEY'S DOCKET NUMBER 10191/2261

17. ☒ The following fees are submitted:	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO $890.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) $710.00		
No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) $740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00		
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

Claims	Number Filed	Number Extra	Rate		
Total Claims	1 - 20 =	0	X $18.00	$0	
Independent Claims	1 - 3 =	0	X $84.00	$0	
Multiple dependent claim(s) (if applicable)			+ $280.00	$	
TOTAL OF ABOVE CALCULATIONS =				$890	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				$	
SUBTOTAL =				$890	
Processing fee of $130.00 for furnishing the English translation later the ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +				$	
TOTAL NATIONAL FEE =				$890	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). $40.00 per property +				$	
TOTAL FEES ENCLOSED =				$890	
				Amount to be: refunded	$
				charged	$

a. ☐ A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒ Please charge my Deposit Account No. 11-0600 in the amount of $890.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-0600. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

By Reg No 35,952

SIGNATURE

Richard L. Mayer, Reg. No. 22,490
NAME

3/4/02
DATE

SEND ALL CORRESPONDENCE TO:
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26646
PATENT TRADEMARK OFFICE

[10191/2261]

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s)	:	Martin KESSLER et al.
Serial No.	:	To Be Assigned
Filed	:	Herewith
For	:	SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD
Art Unit	:	To Be Assigned
Examiner	:	To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT AND
37 C.F.R. § 1.125 SUBSTITUTE SPECIFICATION STATEMENT

SIR:

Please amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

Please cancel original claims 1-4 and please cancel substitute claim 1, without prejudice.

Please add the following new claim:

2. (New) An electronically commutatable motor comprising:

a plurality of excitation windings having a common magnetic circuit;

a corresponding plurality of power semiconductor output stages, the output stages including low-side-connected N-channel MOSFETs,

wherein each of the excitation windings is connected in a series circuit integrally with a respective one of the MOSFETs, the excitation windings being connected to a common direct-current supply voltage, the excitation windings being energized successively in a commutation cycle and being situated alternatingly in opposite directions into the series circuits with the MOSFETs,

wherein, in the context of more than two excitation windings, the commutation cycle extends over an even number of successive, alternatingly oppositely polarized excitation windings, and

wherein, in associated commutation phases, the MOSFETs are driven fully into a conductive state with uniform control signals; and

a smoothing capacitor connected in parallel to the series circuits for transferring back, in a countercurrent direction to the direct-current supply voltage, a disconnection energy transferred in a transformer fashion, upon disconnection of the excitation windings, to a respectively next energizable excitation winding.

Remarks

This Preliminary Amendment cancels without prejudice original claims 1-4 and substitute claim 1 in the underlying PCT Application No. PCT/DE00/02421, and adds without prejudice new claim 2. The new claim conforms the claims to U.S. Patent and Trademark Office rules and does not add new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. § 1.121(b)(3)(iii) and § 1.125(b)(2), a Marked Up Version Of The Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE00/02421 includes an International Search Report, dated December 12, 2000. The Search Report includes a list of

documents that were uncovered in the underlying PCT Application. A copy of the Search Report accompanies this Preliminary Amendment.

The underlying PCT Application No. PCT/DE00/02421 also includes an International Preliminary Examination Report, dated November 6, 2001, a copy of which is included, including a translation.

Applicants assert that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully Submitted,

KENYON & KENYON

By [signature] Reg No 35,952

Dated: 3/4/02

By: [signature]

Richard L. Mayer
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[10191/2261]

SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD

Field Of The Invention

The present invention relates to a system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom.

Background Information

Series circuits of this kind, made up of a power semiconductor output stage and inductive load, are used for a variety of applications. The control signal always fully drives the power semiconductor output stage in order to minimize its power dissipation. When the power semiconductor output stage is disconnected, there occurs at the inductive load a disconnection energy $W = 1/2\ LI^2$ that must be kept away from the power semiconductor output stage, since by way of the latter's parasitic diode the energy would generate a current flow that could result in overload or destruction of the power semiconductor output stage. To prevent this, the load is connected in parallel with a so-called freewheeling diode, which constitutes a power diode and must be matched to the switched power of the series circuit, and is therefore very expensive.

As described in International Patent Publication No. WO 96/09683, it is also known in the context of electronically commutatable motors to incorporate into the freewheeling circuit of an excitation winding the respective excitation winding that is to be energized next, and thereby already to achieve premagnetization. This system nevertheless still requires the freewheeling diode as a coupling diode between the excitation windings.

Summary Of The Invention

It is an object of the present invention to provide a system of the kind mentioned initially that, without a freewheeling diode, protects the power semiconductor output

stage from, and dissipates, the disconnection energy $W = 1/2\ LI^2$ of the inductive load.

This object is achieved, according to the present invention, in that the induced voltage occurring at the inductive load upon disconnection can be transferred in transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

Upon disconnection of the series circuit, the disconnection energy is transferred to the additional inductance, i.e. to a circuit separate from the series circuit, and dissipated through a load. By appropriate coupling of the additional inductance, the energy released can also be transferred back to the direct-current supply voltage. Relevant inductive loads are switching relays, contactors, electronically commutatable motors, and the like.

In the context of a switching relay and a contactor, in simple fashion the design is such that the inductive load and the additional inductance are configured as coils wound in opposite directions having a common magnetic circuit.

For an electronically controllable motor, the additional inductance for an energized energy winding is the oppositely energized excitation winding that is respectively next in the commutation cycle. Particularly simple circuits result if low-side-connected N-channel MOSFETs are used as power semiconductor output stages.

Brief Description Of The Drawings

Figure 1 shows a system having a switching relay switched by way of a power semiconductor output stage.

Figure 2 shows a system having an electronically commutatable motor with four poles and two winding phases as excitation windings.

Detailed Description

The exemplary embodiment according to Figure 1 uses an N-channel MOSFET,

labeled T, to switch on and disconnect inductive load L. Activation is performed with a control signal st that, when present, fully drives power semiconductor output stage T so that the latter's power dissipation is minimal and the maximum current can flow through load L with load resistance RL. In this context, practically the entire direct-current supply voltage Ubatt drops across load L. When power semiconductor output stage T is no longer being activated because control signal st is disconnected, it then assumes the high-resistance switching state in which the parasitic diode of the power semiconductor output stage could constitute a circuit for the induced voltage of load L.

In order to greatly reduce any current flow therethrough, the induced voltage is transferred to an additional inductance Lz that is coupled in transformer fashion to load L, i.e. load L and additional inductance Lz are opposite-direction windings with a common magnetic circuit. If additional inductance Lz is loaded with a resistance R, the induction energy is thereby dissipated. The energy can also, however, as shown by the dashed lines of Figure 1, be transferred back in the countercurrent direction to direct-current supply voltage Ubatt with smoothing capacitor C that is connected in parallel.

The circuit diagram according to Figure 2 shows, as inductive loads L1 and L2, the two excitation windings of an electronically commutatable motor. Loads L1 and L2 are alternatingly energized in the commutation cycle; the energization direction of the excitation windings changes from step to step, since they are incorporated into the series circuits with windings in opposite directions. In the commutation cycle, power semiconductor output stages T1 and T2 are acted upon with the successive control signals st1, st2, st1, st2, ... Upon energization of load L1, load L2 that is coupled in transformer fashion acts as additional inductance Lz, while upon energization of load L2, load L assumes the function of additional inductance Lz. In each energization phase, the circuit shown in Figure 2 operates like the circuit of Figure 1, so that here again freewheeling diodes are not necessary at loads L1 and L2 (i.e. the excitation windings of the motor), and power semiconductor output stages T1 and T2 are protected from the induced voltages occurring upon disconnection.

Abstract Of The Disclosure

A system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom. Protection from the induced voltages is achieved, without a freewheeling diode, in that the disconnection energy occurring at the inductive load upon disconnection can be transferred in transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD

[Background Information] Field Of The Invention

[The]The present invention relates to a system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom.

Background Information

Series circuits of this kind, made up of a power semiconductor output stage and inductive load, are used for a variety of applications. The control signal always fully drives the power semiconductor output stage in order to minimize its power dissipation. When the power semiconductor output stage is disconnected, there occurs at the inductive load a disconnection energy $W = 1/2\ LI^2$ that must be kept away from the power semiconductor output stage, since by way of the latter's parasitic diode the energy would generate a current flow that could result in overload or destruction of the power semiconductor output stage. To prevent this, the load is connected in parallel with a so-called freewheeling diode, which constitutes a power diode and must be matched to the switched power of the series circuit, and is therefore very expensive.

As described in International Patent Publication No. WO 96/09683, it is also known in the context of electronically commutatable motors to incorporate into the freewheeling circuit of an excitation winding the respective excitation winding that is to be energized next, and thereby already to achieve premagnetization. This system nevertheless still requires the freewheeling diode as a coupling diode between the excitation windings.

Summary Of The Invention

It is [the] an object of the present invention to [create] provide a system of the kind mentioned initially that, without a freewheeling diode, protects the power

MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

semiconductor output stage from, and dissipates, the disconnection energy $W = 1/2 LI^2$ of the inductive load.

This object is achieved, according to the present invention, in that the induced voltage occurring at the inductive load upon disconnection can be transferred in transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

Upon disconnection of the series circuit, the disconnection energy is transferred to the additional inductance, i.e. to a circuit separate from the series circuit, and dissipated through a load. By appropriate coupling of the additional inductance, the energy released can also be transferred back to the direct-current supply voltage. Relevant inductive loads are switching relays, contactors, electronically commutatable motors, and the like.

In the context of a switching relay and a contactor, in simple fashion the design is such that the inductive load and the additional inductance are configured as coils wound in opposite directions having a common magnetic circuit.

For an electronically controllable motor, the additional inductance for an energized energy winding is the oppositely energized excitation winding that is respectively next in the commutation cycle. Particularly simple circuits result if low-side-connected N-channel MOSFETs are used as power semiconductor output stages.

[The invention will be explained in more detail with reference to exemplary embodiments depicted in the drawings, in which:] Brief Description Of The Drawings

Figure 1 shows a system having a switching relay switched by way of a power semiconductor output stage[; and].

Figure 2 shows a system having an electronically commutatable motor with four poles and two winding phases as excitation windings.

MARKED-UP VERSION OF SUBSTITUTE SPECIFICATION

Detailed Description

The exemplary embodiment according to Figure 1 uses an N-channel MOSFET, labeled T, to switch on and disconnect inductive load L. Activation is performed with a control signal st that, when present, fully drives power semiconductor output stage T so that the latter's power dissipation is minimal and the maximum current can flow through load L with load resistance RL. In this context, practically the entire direct-current supply voltage Ubatt drops across load L. When power semiconductor output stage T is no longer being activated because control signal st is disconnected, it then assumes the high-resistance switching state in which the parasitic diode of the power semiconductor output stage could constitute a circuit for the induced voltage of load L.

In order to greatly [to] reduce any current flow therethrough, the induced voltage is transferred to an additional inductance Lz that is coupled in transformer fashion to load [V] L, i.e. load L and additional inductance Lz are opposite-direction windings with a common magnetic circuit. If additional inductance Lz is loaded with a resistance R, the induction energy is thereby dissipated. The energy can also, however, as shown by the dashed lines of Figure 1, be transferred back in the countercurrent direction to direct-current supply voltage Ubatt with smoothing capacitor C that is connected in parallel.

The circuit diagram according to Figure 2 shows, as inductive loads L1 and L2, the two excitation windings of an electronically commutatable motor. Loads L1 and L2 are alternatingly energized in the commutation cycle; the energization direction of the excitation windings changes from step to step, since they are incorporated into the series circuits with windings in opposite directions. In the commutation cycle, power semiconductor output stages T1 and T2 are acted upon with the successive control signals st1, st2, st1, st2, ... Upon energization of load L1, load L2 that is coupled in transformer fashion acts as additional inductance Lz, while upon energization of load L2, load L assumes the function of additional inductance Lz. In each energization phase, the circuit shown in Figure 2 operates like the circuit of Figure 1, so that here again freewheeling diodes are not necessary at loads L1 and L2 (i.e. the excitation windings of the motor), and power semiconductor output

stages T1 and T2 are protected from the induced voltages occurring upon disconnection.

Abstract Of The Disclosure

A [The invention relates to a] system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom. Protection from the induced voltages is achieved, without a freewheeling diode, in that the disconnection energy occurring at the inductive load upon disconnection can be transferred in transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD

Background Information

The invention relates to a system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom.

Series circuits of this kind, made up of a power semiconductor output stage and inductive load, are used for a variety of applications. The control signal always fully drives the power semiconductor output stage in order to minimize its power dissipation. When the power semiconductor output stage is disconnected, there occurs at the inductive load a disconnection energy $W = 1/2\ LI^2$ that must be kept away from the power semiconductor output stage, since by way of the latter's parasitic diode the energy would generate a current flow that could result in overload or destruction of the power semiconductor output stage. To prevent this, the load is connected in parallel with a so-called freewheeling diode, which constitutes a power diode and must be matched to the switched power of the series circuit, and is therefore very expensive.

As described in WO 96/09683, it is also known in the context of electronically commutatable motors to incorporate into the freewheeling circuit of an excitation winding the respective excitation winding that is to be energized next, and thereby already to achieve premagnetization. This system nevertheless still requires the freewheeling diode as a coupling diode between the excitation windings.

It is the object of the invention to create a system of the kind mentioned initially that, without a freewheeling diode, protects the power semiconductor output stage from, and dissipates, the disconnection energy $W = 1/2\ LI^2$ of the inductive load.

This object is achieved, according to the present invention, in that the induced voltage occurring at the inductive load upon disconnection can be transferred in

transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

Upon disconnection of the series circuit, the disconnection energy is transferred to the additional inductance, i.e. to a circuit separate from the series circuit, and dissipated through a load. By appropriate coupling of the additional inductance, the energy released can also be transferred back to the direct-current supply voltage. Relevant inductive loads are switching relays, contactors, electronically commutatable motors, and the like.

In the context of a switching relay and a contactor, in simple fashion the design is such that the inductive load and the additional inductance are configured as coils wound in opposite directions having a common magnetic circuit.

For an electronically controllable motor, the additional inductance for an energized energy winding is the oppositely energized excitation winding that is respectively next in the commutation cycle. Particularly simple circuits result if low-side-connected N-channel MOSFETs are used as power semiconductor output stages.

The invention will be explained in more detail with reference to exemplary embodiments depicted in the drawings, in which:

Figure 1	shows a system having a switching relay switched by way of a power semiconductor output stage; and
Figure 2	shows a system having an electronically commutatable motor with four poles and two winding phases as excitation windings.

The exemplary embodiment according to Figure 1 uses an N-channel MOSFET, labeled T, to switch on and disconnect inductive load L. Activation is performed with a control signal st that, when present, fully drives power semiconductor output stage T so that the latter's power dissipation is minimal and the maximum current can flow through load L with load resistance RL. In this context, practically the entire direct-

current supply voltage Ubatt drops across load L. When power semiconductor output stage T is no longer being activated because control signal st is disconnected, it then assumes the high-resistance switching state in which the parasitic diode of the power semiconductor output stage could constitute a circuit for the induced voltage of load L.

In order greatly to reduce any current flow therethrough, the induced voltage is transferred to an additional inductance Lz that is coupled in transformer fashion to load V, i.e. load L and additional inductance Lz are opposite-direction windings with a common magnetic circuit. If additional inductance Lz is loaded with a resistance R, the induction energy is thereby dissipated. The energy can also, however, as shown by the dashed lines of Figure 1, be transferred back in the countercurrent direction to direct-current supply voltage Ubatt with smoothing capacitor C that is connected in parallel.

The circuit diagram according to Figure 2 shows, as inductive loads L1 and L2, the two excitation windings of an electronically commutatable motor. Loads L1 and L2 are alternatingly energized in the commutation cycle; the energization direction of the excitation windings changes from step to step, since they are incorporated into the series circuits with windings in opposite directions. In the commutation cycle, power semiconductor output stages T1 and T2 are acted upon with the successive control signals st1, st2, st1, st2, ... Upon energization of load L1, load L2 that is coupled in transformer fashion acts as additional inductance Lz, while upon energization of load L2, load L assumes the function of additional inductance Lz. In each energization phase, the circuit shown in Figure 2 operates like the circuit of Figure 1, so that here again freewheeling diodes are not necessary at loads L1 and L2 (i.e. the excitation windings of the motor), and power semiconductor output stages T1 and T2 are protected from the induced voltages occurring upon disconnection.

What is claimed is:

1. A system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom,
wherein the disconnection energy ($W = 1/2\ LI^2$) occurring at the inductive load (L, L1, L2) upon disconnection can be transferred in transformer fashion to an additional inductance (Lz, L2, L1) that is loaded with a resistance (R) or is coupled in the countercurrent direction to the direct-current supply voltage (Ubatt).

2. The system as defined in Claim 1,
wherein the inductive load (L) and the additional inductance (Lz) are configured as coils wound in opposite directions having a common magnetic circuit (Figure 1).

3. The system as defined in Claim 1,
wherein in the context of an electronically commutatable motor, the additional inductance for an energized excitation winding (e.g. L1) is the oppositely energized excitation winding (L2) that is respectively next in the commutation cycle.

4. The system as defined in one of Claims 1 through 3,
wherein the power semiconductor output stages (T, T1, T2) are low-side-connected N-channel MOSFETs.

Abstract

The invention relates to a system for protecting a power semiconductor output stage that, as a function of a control signal, connects an inductive load to a direct-current supply voltage and disconnects it therefrom. Protection from the induced voltages is achieved, without a freewheeling diode, in that the disconnection energy occurring at the inductive load upon disconnection can be transferred in transformer fashion to an additional inductance that is loaded with a resistance or is coupled in the countercurrent direction to the direct-current supply voltage.

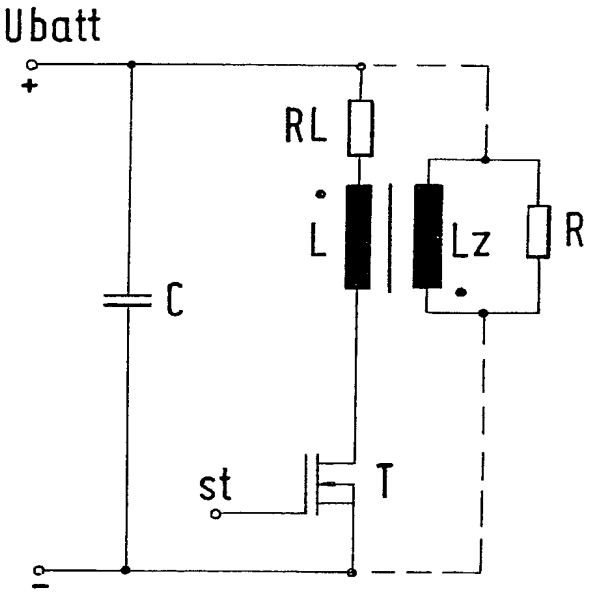

Fig.1

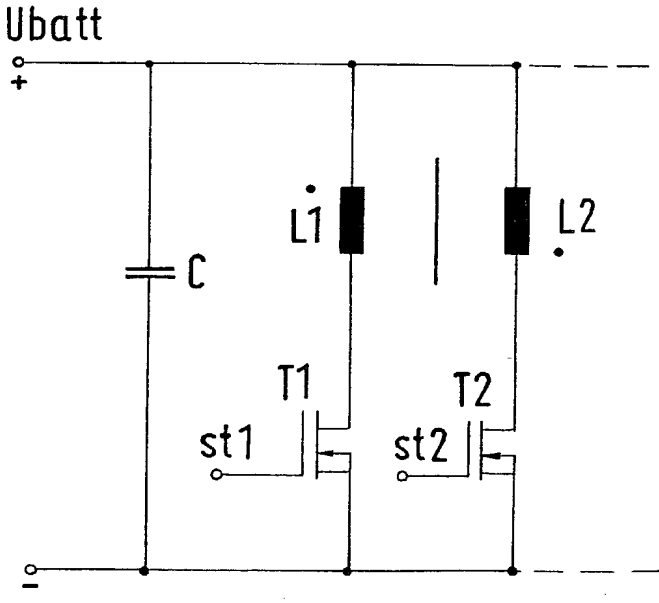

Fig.2

COMBINED DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below adjacent to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **"SYSTEM FOR PROTECTING A POWER SEMICONDUCTOR OUTPUT STAGE THAT SWITCHES AN INDUCTIVE LOAD"**, and the specification of which:

[ ] is attached hereto;

[ ] was filed as United States Application Serial No. _____ on _____, ____ and was amended by the Preliminary Amendment filed on _____, ____.

[X] was filed as PCT International Application Number PCT/DE00/02421, on the 25th day of July 2000.

[X] an English translation of which is filed herewith.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). I hereby claim foreign priority benefits under Title 35, United States Code § 119 of any foreign application(s) for patent or inventor's certificate or of any PCT international applications(s) designating at least one country other than the United States of America listed below and have also identified below any foreign application(s) for patent or inventor's certificate or any PCT international application(s) designating at least one country other than the United States of America filed by me on the same subject matter having a filing date before that of the application(s) of which priority is claimed:

PRIOR FOREIGN/PCT APPLICATION(S)

AND ANY PRIORITY CLAIMS UNDER 35 U.S.C. § 119

Country : Germany

Application No. : 199 41 698.2

Date of Filing: September 2, 1999

Priority Claimed
Under 35 U.S.C. § 119 : [X] Yes [ ] No

I hereby claim the benefit under Title 35, United States Code § 120 of any United States Application or PCT International Application designating the United States of America that is/are listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations § 1.56(a) which occurred between the filing date of the prior application(s) and the national or PCT international filing date of this application:

PRIOR U.S. APPLICATIONS OR
PCT INTERNATIONAL APPLICATIONS
DESIGNATING THE U.S. FOR BENEFIT UNDER 35 U.S.C. § 120

U.S. APPLICATIONS

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I hereby appoint the following attorney(s) and/or agents to prosecute the above-identified application and transact all business in the Patent and Trademark Office connected therewith.
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

1-00

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